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(72) Inventor: **Adami, Mauro**
55049 Viareggio, Lucca (IT)

(74) Representative: **Mannucci, Michele et al**
Ufficio Tecnico Ing.A. Mannucci,
Via della Scala 4
50123 Firenze (IT)

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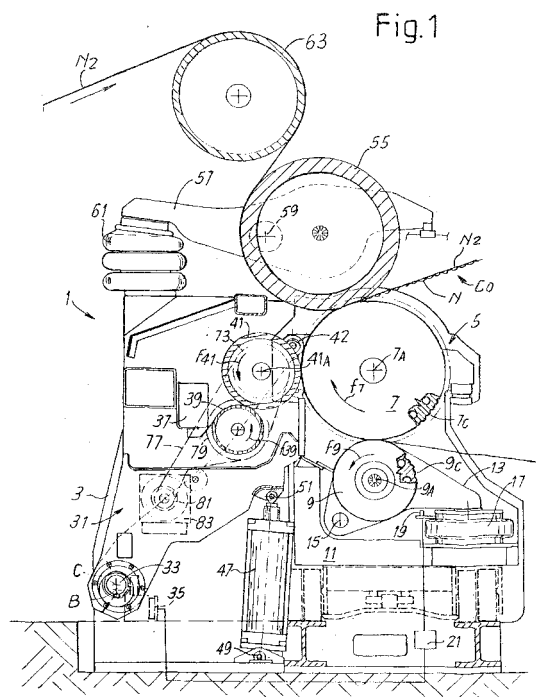
(71) Applicant: **FOSBER S.p.A.**
I-55100 Lucca (IT)

(54) **Device for controlling the distance between a glueing cylinder and a corrugating roller for a cardboard corrugating machine**

(57) The machine for the production of corrugated cardboard comprises:

- a first corrugating roller (7);
- a second corrugating roller (9) co-operating with the first corrugating roller for corrugating a sheet of web-like material (N), which passes between said first corrugating roller and said second corrugating roller, which are provided with projections that mesh together;
- a glueing assembly (31) with a glueing cylinder (41), which co-operates with the first corrugating roller for applying a glue on the crests of said web-like material; and
- adjustment means for adjusting the position of the glueing cylinder with respect to the first corrugating roller.

The adjustment means comprise a detector for detecting an angular displacement between the glueing cylinder and a wheel for transmitting motion to the cylinder. The position of the glueing cylinder with respect to the corrugating roller is adjusted according to said angular displacement.



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Description

Technical field

[0001] The present invention relates to a machine for the production of corrugated cardboard and, more in particular, to an improvement of the control system for controlling the distance between the gluing cylinder and the main corrugating roller, over which is run the web-like material, which it is to receive the glue delivered by the gluing cylinder on the crests formed by the two corrugating rollers.

State of the art

[0002] Plants for the production of corrugated cardboard comprise a series of machines or workstations, among which one or more machines, referred to in the art as "single facers", which comprise a pair of corrugating rollers that co-operate with one another, each of which presents ribs and grooves that mesh together, whilst a web-like material, namely a sheet or web of paper or cardboard, passes through the gap between the two rollers, so that said web-like material undergoes corrugation.

[0003] The web-like corrugated material remains adherent to the first corrugating roller and passes in front of a gluing cylinder, which applies an adhesive on the crests of the corrugations formed on the web-like material itself. Downstream of the gluing area, on the crests of the corrugated material, moistened with glue, there is applied a second smooth web-like material, for instance, a sheet of paper or cardboard, which forms the so-called "cover" of the corrugated cardboard. A second cover is then applied on the opposite face of the corrugated web-like material in a machine set downstream.

[0004] One of the critical aspects of single facers consists in controlling the relative position between the first corrugating roller, over which the web-like material that is to undergo corrugation is run, and the gluing cylinder. In fact, the distance between the surface of the gluing cylinder and the surface to be glued must be controlled in such a way as to guarantee a uniform application of the glue on all the crests and on all the transverse length of the web-like material, i.e., on all the length of each crest. Normally, the surface of the gluing cylinder does not touch the material; instead, a very small distance is left between them, of the order of magnitude of the thickness of the film of glue which coats the active surface of the gluing cylinder.

[0005] The control of the relative position between the corrugating roller (or, more precisely, between the corrugated paper material lying on the roller itself) and the gluing cylinder is a critical aspect of the production cycle of corrugated cardboard, in so far as it is upon the correct control of this parameter that the quality of gluing between the corrugated sheet of cardboard and the smooth sheet of cardboard, i.e., the so-called cover, de-

pends. An other than accurate control entails a non-uniform distribution of adhesive and hence the risk that the two sheets, the smooth one and the corrugated one, will remain not accurately glued to one another.

[0006] During operation of the machine, variations in the operating conditions occur, which can affect proper gluing. In particular, the set comprising the first corrugating roller and the second corrugating roller can be replaced at every order change, when the shape and size of the corrugation on the cardboard varies from one order to the next. Insertion into the machine of a so-called "cartridge", i.e., of the set of the two corrugating rollers, entails the need for an adjustment of the position of the gluing cylinder with respect to the first corrugating roller.

[0007] Another factor that must be taken into account for achieving proper gluing is the possible fluctuation in the thickness of the web-like paper material fed into the machine. This thickness may vary, for example, when the reel from which the material is fed towards the single facer is replaced. Even very small variations in the thickness of the paper may lead to substantial variations in the application of the glue on the web-like material.

[0008] Furthermore, during operation of the machine, there occurs a gradual heating of the corrugating rollers, which are brought up to temperature by means of a suitable heating system, for instance by steam, which is made to circulate in chambers adjacent to the surface of the corrugating rollers. This heating process brings about an expansion of the corrugating rollers. Any increase in diameter of the first corrugating roller, with which the gluing cylinder co-operates, must be matched by an adjustment in the position of the gluing cylinder in order to maintain optimal conditions of application of the glue. The diameter may vary as a result of temperature fluctuations during operation.

[0009] Not the least important factor that renders the control of the distance between the gluing cylinder and the corrugating roller critical is the wear, especially of the corrugating roller, and hence its gradual reduction in diameter.

[0010] Various systems have thus been devised for carrying out an accurate control of the relative position between the corrugating roller and the gluing cylinder, i.e., for controlling the so-called "glue gap".

[0011] In EP-B-0601528, a single-facer machine of the above-mentioned type is described, in which a special sensor continuously detects the relative distance between the gluing cylinder and the first corrugating roller. The gluing assembly of which the gluing cylinder forms part is provided with a contrast, which co-operates with a fixed part of the frame of the machine. The contrast can be lengthened or shortened by means of a special actuator, in such a way as to modify the effective distance between the gluing cylinder and the corrugating roller and to maintain this distance constantly equal to a desired value. The system is particularly complex and does not guarantee a sufficient reliability in the po-

sitioning between the gluing cylinder and the corrugating roller. In particular, the sensor is set in a critical area of the machine and is subject to high thermal stresses, as well as being affected by the vibrations of the device. Furthermore, the system does not take into account the wear of the corrugating roller and any differential thermal expansion due to the fact that the roller itself is subject to different temperatures in the various areas thereof.

[0012] In EP-A-0870598 it is suggested not to maintain a fixed distance between the web-like corrugated material (and hence the corrugating roller) and the gluing cylinder. Instead, the machine described in this prior document envisages that the gluing cylinder be pressed against the crests of the paper sheet or corrugated cardboard run over the first corrugating roller, hence eliminating the distance between the cardboard and the gluing cylinder. This solution, on the one hand, simplifies control of the position of the gluing cylinder, but, on the other, does not provide a satisfactory gluing quality. In fact, on account of the force of contact between crests of the corrugated cardboard and the gluing cylinder, the glue tends to be pushed away from the tops of the crests and to be distributed over the sides of the crests, where it does not contribute to the subsequent gluing of the cover. In addition, the forced contact between the gluing cylinder and the corrugating roller leads to the generation of major vibrations and a high wear of the machine members.

[0013] In EP-A-1086805 the relative position between the gluing cylinder and the corrugating roller is controlled by pressing the end supports of the gluing cylinder against the end supports of the corrugating roller and by measuring the force of contact. Moreover provided is a mechanism which makes it possible to increase or reduce the distance between these supports until a desired contact force is achieved. Corresponding to this is a very precise relative position between the active surface of the gluing cylinder and the web-like corrugated paper material that is run over the corrugating roller. This system proves very complex on account of the need to have available a plurality of actuators. A particularly critical and complex aspect is the mechanism for adjusting the distance between the end supports of the gluing cylinder and those of the corrugating roller.

[0014] In EP-B-0786329 there are described single facers with systems for controlling the distance between the gluing cylinder and the corrugating roller, said systems being based upon detection of an operating parameter. This parameter may be vibration, noise, the torque applied to the gluing cylinder, or the force of reaction between the gluing cylinder and the corrugating roller. The measurements thus made are all affected by error, in so far as, whatever the parameter considered, it is influenced not only by the distance between the gluing cylinder and the corrugating roller, but also by external factors which have nothing to do with said distance. The control is, therefore, far from accurate and is ren-

dered complex by the need to use particularly delicate sensors.

[0015] EP-A-0734849 describes a single facer in which the distance between the corrugating roller and the gluing cylinder is controlled by detecting speed. A first detection means reads the peripheral speed of the corrugating roller and a second means reads the peripheral speed of the gluing cylinder. The detecting means are associated to motors which drive the corrugating roller and the gluing cylinder respectively. Gluing cylinder rotation is kept at certain value so that the peripheral speed of the gluing cylinder is different from the peripheral speed of the corrugating roller. The distance between the corrugating roller and the gluing cylinder is adjusted by gradually approaching the gluing cylinder to the corrugating roller until a variation of the rotation speed of the gluing cylinder (caused by the contact of the cylinder with the cardboard running over the corrugating roller) is detected. The distance between the two elements is fixed at this point. The system is not very efficient because the friction generated by effect of the contact of the paper running over the corrugating roller and the gluing cylinder is not sufficient to provide angular acceleration to the gluing cylinder and the associated drive. However, acceleration occurs only after the gluing cylinder is moved excessively close to the corrugating roller and pressed onto the cardboard with considerable force.

[0016] Furthermore, the device described in EP-A-734849 does not envisage the possibility of adapting the distance between the gluing cylinder and the corrugating roller while processing a single job, i.e. during the production of a certain type of material. The distance is adapted only when the job is changed. Consequently, the device does not account for: (a) roller diameter variations caused by temperature oscillations during the process deriving also from variations in speed; (b) variations of thickness of each sheet of cardboard from the same reel due to, for example, slight oscillations in cardboard sheet production parameters.

Objects and summary of the invention

[0017] An object of the present invention is to provide a machine for the production of corrugated cardboard, or so-called "single facer", in which it is possible to control, in a reliable, accurate and simple way, the position of the cylinder with respect to the corrugating roller with which the cylinder co-operates.

[0018] An object of the present invention is also to provide a method for controlling the operating condition of the gluing cylinder with respect to the corrugating roller.

[0019] The above and further objects and advantages are achieved basically with a single facer comprising:

- a first corrugating roller;
- a second corrugating roller co-operating with the first corrugating roller for corrugating a sheet of

web-like material, which passes between said first corrugating roller and said second corrugating roller, which are provided with projections and grooves that mesh together;

- a gluing assembly with a gluing cylinder which cooperates with the first corrugating roller for applying a glue on the crests of said web-like material;
- means for transmitting motion to the gluing cylinder that turns the gluing cylinder at a peripheral speed which is different than the peripheral speed of the first corrugating roller or more precisely which is different than the peripheral speed of the web-like material adhering to the roller;
- adjustment means for adjusting the position of the gluing cylinder with respect to the first corrugating roller;

characterized in that the adjustment means comprise a detector for detecting an angular displacement between the gluing cylinder and the motion transmission means, the position of the gluing cylinder with respect to the first corrugating roller being controlled according to said angular displacement.

[0020] Essentially, therefore, the parameter used to adjust the relative distance between corrugating roller and gluing cylinder is a modification in the relative angular position between the gluing cylinder and a member for transmitting motion to said gluing cylinder, for example a wheel, such as a gear wheel or a pulley. An extremely low inertia system is obtained as a result. The angular position of the gluing cylinder with respect to the respective motion transmission means changes rapidly, as soon as a frictional force is applied to the cylinder by the web-like material running over the crests of the corrugating roller. This ensures very accurate regulation of the distance between the corrugating roller and the gluing cylinder.

[0021] In practice, the gluing assembly is mounted in such a way that it can move with respect to the first corrugating roller, the position of the gluing assembly being modified according to the variation in the angular position of the gluing cylinder with respect to a member for transmitting motion to the cylinder.

[0022] According to a practical embodiment, the gluing cylinder is driven in rotation with a peripheral speed lower than the peripheral speed of the sheet of web-like material run over the first corrugating roller, for example, 0.5%-10% lower, and preferably 1%-5% lower. In this way, when the gluing cylinder approaches the corrugating roller excessively, or, more exactly, when it approaches the corrugated web-like material lying on the corrugating roller, the web-like material applies a force of friction and hence an effect of drawing on the gluing cylinder, which causes the angular displacement between cylinder and wheel transmitting motion to the cylinder.

[0023] Preferably, according to a possible embodiment, the motion transmission means comprise a wheel

which is coaxial to the gluing cylinder, connected thereto in such a way as to be able to perform a limited angular movement with respect to the gluing cylinder, and which is driven by a transmission member, e.g. a flexible belt or chain member. Furthermore, a sensing means is provided to detect the angular displacement between the gluing cylinder and the wheel.

[0024] In practice, the gluing cylinder may assume a displaced angular position, with respect to the mechanical transmission that turns it. In a first possible embodiment of the device, the displacement is detected, for example, by a load cell, or other sensor, suitably arranged between a support of the gluing cylinder and its respective axis.

[0025] According to a practical embodiment, limiting means are provided to limit the angular displacement between said wheel and the gluing cylinder.

[0026] In a possible embodiment, the detector comprises a mobile member, e.g. pivoting, cooperating with a cam, the relative position of said mobile member and said cam being determined by the angular position of said wheel and said gluing cylinder. Furthermore, a sensor means (e.g. a microswitch, a capacitive sensor, a magnetic sensor or other) is provided to detect the movement of the mobile member controlled by the cam.

[0027] Essentially, regardless of the system used to detect the variation in angular position of the gluing cylinder and the motion transmission, the cylinder works as a switch which is operated as a consequence of the frictional force applied to the cylinder by the corrugating roller or more precisely by the web-like material running over the roller.

[0028] According to the present invention, there is also provided a method for controlling the distance between a gluing cylinder and a first corrugating roller in a machine for producing corrugated cardboard, which comprises said gluing cylinder, said first corrugating roller and a second corrugating roller, which cooperates with the first corrugating roller to corrugate a sheet of web-like material, upon which said gluing cylinder applies a glue. The corrugating roller and the gluing cylinder are turned at reciprocally different peripheral speeds. The adjusting method according to the invention is characterized in that the reciprocal position of the corrugating roller and the gluing cylinder is adjusted by gradually approaching the gluing cylinder and the corrugating roller until an angular shift or displacement between the gluing cylinder and a motion transmitting means of the cylinder is caused by the frictional force transmitted by the web-like material running over the corrugating roller. The angular displacement is used as a signal to set the reciprocal distance between the gluing cylinder and the corrugating roller.

[0029] Further advantageous features and embodiments of the machine and of the method according to the invention are specified in the attached claims and will be described with reference to a non-limiting example of embodiment.

Brief description of the drawings

[0030] A better understanding of the invention will be obtained from the ensuing description and from the attached drawing, which shows a practical non-limiting example of embodiment of the invention. In the attached drawing:

- Figures 1 and 2 illustrate two side views of the machine according to the present invention in two different configurations of the gluing assembly;
- Figures 3 and 4 illustrate two longitudinal cross-sectional views of the gluing cylinder according to two planes III-III and IV-IV in Fig.5; and
- Figure 5 is a partial, frontal cross-sectional view according to V-V in figures 3 and 4.

Detailed description of a preferred embodiment of the invention

[0031] Figure 1 illustrates the machine with the gluing assembly in the working position, with the gluing cylinder in contact with the web-like material run over the first corrugating roller, whilst Figure 2 illustrates the same machine with the gluing assembly in the opened condition, i.e., with the machine pre-arranged so as to enable replacement of the set or cartridge of corrugating rollers, for instance, when there is a change of production order.

[0032] The machine, designated as a whole by 1, has a load-bearing structure 3, on which an assembly 5 is fitted, the said assembly comprising a first corrugating roller 7 and a second corrugating roller 9. The two corrugating rollers 7 and 9 are mounted on a unit or cartridge 11, which can be inserted into and removed from the machine for replacement of the corrugating rollers themselves with others having a different configuration of the ribs that have the function of corrugating the web-like material that is fed into the machine.

[0033] The corrugating roller 7 has a plurality of ribs or undulations 7C on its own cylindrical surface, with which corresponding undulations or ribs 9C of the second corrugating roller 9 mesh. Through the gap defined between the two rollers 7 and 9, where the ribs 7C and 9C mesh into one another, a web-like material N is made to pass, for example a sheet of paper or cardboard, which undergoes corrugation between the two rollers 7 and 9, said web-like material N remaining adherent, at output from the gap between the said rollers, to the first corrugating roller 7, for instance, by means of a suction system or a pressurized-air system of a type in itself known. The first corrugating roller 7 turns about an axis 7A in the direction indicated by the arrow f7, the axis 7A being substantially fixed with respect to the unit 11, which supports the rollers 7 and 9. Instead, the second corrugating roller 9 is supported by a pair of arms 13, which are hinged about an axis of oscillation 15, parallel to the axis 7A of the first corrugating roller 7 and to the axis 9A, about which the second corrugating roller 9

turns in the direction indicated by the arrow f9. The second corrugating roller 9 is forced against the first corrugating roller 7 by means of a pair of actuators (a pair of so called torpresses, in the example illustrated), designated by 17, which act upon the two end arms 13 that support the axis 9A of the corrugating roller 9. The position of the arms 13, and hence of the second corrugating roller 9 with respect to the unit 11, and hence with respect to the structure 3 of the machine 1, is detected by means of a sensor designated by 19, said sensor being interfaced with a control unit 21, for the purposes specified hereinafter. Said sensor could be omitted in certain embodiments of the machine and in certain implementations of the control method. The corrugating roller 9 may be made with a diameter that is even much smaller (as compared to the one represented in the figure) than the diameter of the corrugating roller 7. This reduces the number of ribs 7C, 9C meshing together in the area of co-operation between the two corrugating rollers, and consequently facilitates the formation of the corrugation on the web-like material N, as is known to persons skilled in the art. in order to overcome the excessive flexibility of the corrugating roller 9 when this has a particularly small diameter, it may be envisaged that it is supported in an intermediate position between the arms 13 by one or more supporting belts carried by the unit 11, which are appropriately run over the bottom portion of the corrugating roller 9.

[0034] Constrained to the structure 3 of the machine is a gluing assembly, designated as a whole by 31. The gluing assembly 31 is hinged about an axis of oscillation B parallel to the axes 7A and 9A of the corrugating rollers 7 and 9. The geometrical axis of oscillation B is parallel to a second axis C of an eccentric cam 33. The angular position of the eccentric cam 33 may be modified by means of an actuator, for instance a stepper motor reducer 35. The rotation of the eccentric cam 33 about the axis C brings about a modification in the position of the geometrical axis B of oscillation of the gluing assembly 31 for the purposes described hereinafter.

[0035] The gluing assembly 31 carries a glue tank 37, from which the glue is taken by means of a transferor cylinder 39, which turns in the direction indicated by the arrow f39. The transferor cylinder 39 is tangential to a gluing cylinder 41, which turns in the direction indicated by the arrow f41, in the same direction as the transferor cylinder 39 and in contact with the latter. In this way, the glue is transferred from the tank 37 onto the cylindrical surface of the gluing cylinder 41, and therefrom to the crests of the web-like material N, which is run over the first corrugating roller 7 and previously deformed in the gap between the corrugating roller 7 and the corrugating roller 9.

[0036] The working position of the gluing assembly 31 is defined by the position of the axis B and by a pair of eccentric pins 42 carried by the unit 11.

[0037] Whenever a unit 11 is inserted into the machine, the eccentric pins 42 carried by the unit 11 are

adjusted to adjust the position of the gluing assembly 31 in such a way that the axis of the gluing cylinder 41 is perfectly parallel to the axis 7A of rotation of the first corrugating roller 7. This adjustment operation is normally carried out just once, when a set of corrugating rollers 7, 9 carried by the unit 11 are inserted into the machine.

[0038] Oscillation of the gluing assembly 31 about the axis B is controlled by means of a cylinder-piston actuator 47, which is hinged in 49 to the fixed structure 3 of the machine and in 51 to the gluing assembly 31. The positions of working and opening of the gluing assembly 31 are shown in Figures 1 and 2, as mentioned above. In the position illustrated in Figure 2, the gluing assembly 31 has been moved away from the corrugating roller 7 to enable replacement of the unit 11, which carries the corrugating rollers 7 and 9.

[0039] Along the development of the corrugating roller 7, downstream of the gluing area defined by the position of the gluing cylinder 41, there is provided a pressure roller 55 supported by a pair of arms 56, which are hinged in 59 to the fixed structure 3 and which are forced by actuators 61 so that they press the pressure roller 55 against the corrugating roller 7. Run over the pressure roller 55 is a second continuous web-like material, for example, a sheet of paper material designated by N2, said material being guided by a cylinder 63. The web-like material N2 is applied by pressure exerted by the roller 55 onto the crests of the web-like material N previously provided with glue by means of the gluing cylinder 41. The second web-like material N2 constitutes the so-called "cover" of the corrugated cardboard produced by the machine. The corrugated cardboard, designated by CO, is thus made up of the corrugated web-like material N glued onto the smooth web-like material N2. In a way of itself known, this material is then sent on to a further machine for application of a second smooth sheet on the opposite face, and is then possibly combined with other sheets of corrugated cardboard.

[0040] As shown, in particular, in the longitudinal sections of the gluing cylinder 41 shown in Figures 3 and 4, the gluing cylinder 41 is supported on the gluing assembly 31 by means of a pair of bearings 71. Mounted at one end of the gluing cylinder 41 is a pulley 73, with interposition of a mechanism 75 (described below) which permits a limited angular movement to the pulley 73 on the axis 41A of the cylinder 41 to which the pulley 73 is coaxial. Run over the pulley 73 is a toothed belt 77, which is then run over a further pulley 79, fitted on the axis of the transferor cylinder 39 and run over a motor-driven pulley 81, which receives motion from a motor 83. The latter then drives in rotation the transferor cylinder 39 and the gluing cylinder 41 by means of the belt 77.

[0041] The peripheral speed of the gluing cylinder 41 applied by the motor 83 is chosen in such a way as to be slightly lower than the peripheral speed of the first corrugating roller 7, and, more precisely, slightly lower

than the peripheral speed of the most radially external points (i.e., the crests) of the corrugated web-like material N, which passes between the rollers 7 and 9 and is run over the corrugating roller 7. Characteristically, the difference in peripheral speed may be in the range of 0.5% to 10%, and preferably between 1% and 5%.

[0042] With an arrangement of this type it is possible to control and adjust the position of the gluing cylinder 41 with respect to the corrugating roller 7, using as control parameter the angular position of the pulley 73 with respect to the gluing cylinder 41, in the way described hereinafter.

[0043] A wheel 101 (also see Figure 5) is fitted on the shaft 42 (Figures 3 and 4), integral with the gluing cylinder 41 and supported in the bearing 71; a radial spline 103 is integral with the wheel. The spline 103 is arranged in a tangential housing 105 delimited by two contrasts 107A, 107B in the body of the pulley 73. The two contrasts 107A and 107B are reciprocally distanced by an angle comprised, for example, in the range from approximately 5° to approximately 25°, for example approximately 15°. In this way, the toothed pulley 73 (on which the belt 77 runs) can oscillate on the axis 41A with respect to the gluing cylinder 41 by an angle corresponding to that defined by the two contrasts 107A, 107B.

[0044] A cam profile 109 is formed on the front surface of the wheel 101 on which a feeler 111 rests, said feeler being formed by an arm hinged on an axis 111A oriented by 90° with respect to the axis 41A of the gluing cylinder 41. The contact between the feeler arm 111 and the cam 109 is ensured by a spring arranged between the feeler arm 111 and a cover 113 fastened on the pulley 73. A cup or plate 115, which can project into a central aperture 117 made in the cover 113, is integral with the feeler arm 111. A microswitch 119 or other sensing means, e.g. inductive, capacitive or other, is arranged in front of said aperture and interfaces with the machine control unit. The material of the plate or cup 115 shall be chosen according to the type of sensor employed.

[0045] Regardless of the type employed, the sensor shall be capable of detecting whether the plate or cup 115 is in extracted or retracted position with respect to the housing formed by the wheel or pulley 73 and the cover 113.

[0046] The device so far described operates as follows. Once the unit 11 is inserted into the machine, the gluing assembly 31 is brought into the working position (see Figure 1), retracting the actuator 47 until the gluing assembly is brought right up against the eccentric cams 42. By adjusting the angular position of the eccentric cams 42, the axis of the gluing assembly 41 is brought up parallel with the axis of the corrugating roller 7. The eccentric cam 33 is brought into an angular position such as to bring the gluing cylinder 41 to the maximum distance from the corrugating roller 7.

[0047] In the above configuration, the distance between the active cylindrical surface of the gluing cylinder 41 and the web-like material N run over the corrugating

roller 7 is certainly greater than the optimal distance for obtaining perfect gluing. In order to adjust this distance to the appropriate value, after starting up feeding of the web-like material N through the machine, the actuator 35, which turns the eccentric cam 33, is activated, so bringing the axis of oscillation B closer to the vertical plane containing the axis 7A of the corrugating roller 7, whilst the machine is brought up to the operating speed, with the gluing cylinder 41 that turns at a slightly lower speed than that of the web-like material run over the first corrugating roller 7.

[0048] In these conditions, the cylinder 41 is turned by effect of one of the contrasts 107A, 107B which rests on the spline 103 and draws in rotation the wheel 101, and consequently the shaft 42, with which it is integral; the shaft in turn is integral with the gluing cylinder 41. The plate or cup 115 is in retracted position because in this angular position (Figure 5) the feeler arm 111 is not in contact with the raised profile of the cam 109. When the gluing cylinder 41 approaches the corrugated web-like material resting on the ribs of the first corrugating roller 7, the force of friction that is generated between the web-like material and the gluing cylinder 41 (increased by the presence of the layer of glue on the gluing cylinder 41) moves the gluing cylinder 41 forward by a few degrees causing a relative angular shift or displacement between the cylinder (and consequently the wheel 101 integral therewith) and the motion transmitting pulley 73. The angular shift or displacement is limited by the other of the two contrasts 107A, 107B against which the radial spline 103 now rests. The reciprocal angular displacement between the wheel 101 and the wheel or pulley 73 is sufficient to move the feeler arm 111 up on the cam profile 109, whereby causing the plate or cup 115 to move outwards. This movement is detected by the microswitch 119 which generates a signal detected by the control unit 21.

[0049] The angular displacement between gluing cylinder 41 and wheel or pulley 73 is determined by the fact that the web-like material advances at a different speed (higher in this case) than that of the peripheral speed of the gluing cylinder 41 moved by its respective drive. Consequently, the web-like material N starts to exert on the gluing cylinder 41 a frictional force and hence an effect of drawing even prior to contact between the web-like material itself and the active surface of the cylinder on account of the presence of the film of glue on the cylinder itself.

[0050] Since the gluing cylinder 41 is free to be angularly displaced by a certain extent (defined by the distance between the contrasts 107A and 107B) with respect to the pulley 73 thanks to the spline 103 and to the two contrasts 107A, 107B, the effect of this frictional force will be to cause the angular displacement of the cylinder 41 with respect to transmission of motion to the cylinder, with the generation of the signal by the microswitch 119.

[0051] The distance between the gluing cylinder 41

and the corrugating roller 7 is fixed by arresting rotation of the eccentric cam 33 when microswitch 119 detects the movement of the feeler arm 111 or else, and preferably, the eccentric cam 33 is caused to rotate again in the opposite direction as soon as the microswitch 119 detects the displacement of the feeler arm 111. Displacement in the opposite direction is performed to a certain extent determined by the angle of rotation of the cam 33. The predetermined rotation corresponds to a predetermined distance between the active surface of the gluing cylinder 41 and the surface of the crests of web-like material on the corrugating roller. In this way, in practice, the angular displacement detected by the microswitch 119 is used to define a zero point from which the machine control system starts to impose to the gluing cylinder a predetermined distance from the corrugated roller, by distancing the gluing cylinder from the corrugating roller by a predetermined extent which can be programmed by the operator. This predetermined distance can be defined according to the production speed of the machine, the characteristics of the material being processed and other parameters.

[0052] Since, during operation, there may be variations in the diameter of the corrugating roller 7 on account of its being heated and/or variations in the thickness of the web-like material N that is fed in, the unit 21, which is interfaced with the microswitch 119 and with the actuator 35, is always able to detect any possible angular displacement of the gluing cylinder 41 with respect to the pulley 73 that is due to the reduction in the distance between the cylinder 41 itself and the corrugated web-like material N. When this situation arises, the actuator 35, which moves the gluing assembly 31 and hence the gluing cylinder 41 away from the corrugating roller 7 by the necessary amount, is activated. The adjustment is extremely accurate thanks to the distance of the axis of oscillation B from the resting point defined by the eccentric contrasts 42. In practice, to avoid such an occurrence, the control system is programmed to regularly and gradually approach the gluing cylinder 41 to the corrugating roller 7 and consequently distance the two elements by a predetermined extent starting from the zero position defined by detecting the angular displacement between the gluing cylinder 41 and the pulley 73. In this way, the correct reciprocal distance between the roller 7 and the cylinder 41 is regularly restored without ever being excessively close due to the accidental dilatation of the corrugating roller 7. Similarly, excessive distance between the corrugating roller 7 and the gluing cylinder 41 is avoided due to the reduction in diameter of the roller 7 consequent to cooling.

[0053] The frequency according to which the reciprocal distance between corrugating roller 7 and gluing cylinder 41 is restored can be determined also according to the production speed or other advantageous considerations.

[0054] This mode of operation accounts for possible variation in diameter of the corrugating roller due to tem-

perature variations as well as possible oscillations in paper thickness.

[0055] A load cell or other equivalent sensor can be fitted on either one or both contrasts 107A, 107B to detect the movement of the spline 103 instead of the microswitch 119 and the respective members which are employed to detect the angular movement of the cylinder 41 with respect to the pulley 73. The solution described above presents the advantage of not requiring wiring inside the pulley 73.

[0056] According to a different mode of operation, the control of the distance between the gluing cylinder 41 and the corrugating roller 7, when the first adjustment of the position of the gluing assembly 31 has been carried out via rotation of the eccentric cam 33, the maintenance of the distance between the corrugated web-like material N and the active surface of the gluing cylinder 41 can be entrusted to the sensor 19. In fact, the position of the arms 13, and hence of the second corrugating roller 9 with respect to the axis of rotation 7A of the first corrugating roller 7, depends upon the diameter of the corrugating roller 7 itself, upon the diameter of the corrugating roller 9, and upon the thickness of the web-like material N passing between the two corrugating rollers. If the variation in diameter of the corrugating roller 9 during operation is assumed as being negligible, for the reasons clarified hereinafter, the position read by the sensor 19 is a function of the variation in diameter of the corrugating roller 7 and of the variation in the thickness of the web-like material N. This variation is the one that affects the distance between the crests of the corrugation of the web-like material N and the active surface of the gluing cylinder 41. Consequently, the actuator 35, which modifies the position of the axis of oscillation B, and hence of the gluing assembly 31, with respect to the corrugating roller 7 can be interlocked to the signal detected by the sensor 19 through a control made by the control unit 21.

[0057] An approach of the arm 13 to the sensor 19 indicates an increase in the thickness of the web-like material N and/or an increase in the diameter of the corrugating roller 7, and hence there derives therefrom the need to rotate the eccentric cam 33 by means of the actuator 35 to move the gluing cylinder 41 away from the axis of rotation 7A of the corrugating roller 7. An increase in the distance read by the sensor 19 indicates, instead, a reduction in the thickness of the web-like material and/or a reduction in the diameter of the corrugating roller 7, and hence the consequent need to reduce the distance between the gluing cylinder 41 and the axis 7A of rotation of the corrugating roller 7.

[0058] With the signal coming from the sensor 19, it is therefore possible to obtain a continuous control of the distance between the gluing cylinder 41 and the corrugating roller 7, without having to carry out periodic approach and recession of the gluing assembly 31 in order to detect the angular displacement of the gluing cylinder 41 with respect to the motion transmission means 77,

73, as described previously, and limiting this operation just to the initial stage of adjustment, when starting up the machine.

[0059] The variation in the diameter of the corrugating roller 7, of which account is not taken in the adjustment described above by means of the signal of the sensor 19, is neglected in that the smaller diameter of this roller leads to a smaller variation in its dimensions due to the fluctuation in temperature. In addition, the variation in diameter of the corrugating rollers is mainly due to a variation in the thermal flow removed from the web-like material N during operation of the machine. In fact, if the machine increases its speed, the web-like material that is passing through it per unit time increases, and consequently also the heat removed by thermal conduction between the corrugating roller and the web-like material increases. Since the arc of contact between the web-like material N and the second corrugating roller 9 is very small and negligible as compared to the extensive arc of contact of the web-like material N with the top corrugating roller 7, this variation in the thermal flow removed from the web-like material N as a function of the variation in the operating conditions of the machine is negligible. Consequently, the dimensional variation of the corrugating roller 9 with respect to the dimensional variation of the corrugating roller 7 is negligible.

[0060] It is understood that the drawing only shows an example of embodiment provided purely as a practical demonstration of the invention, which may vary in its embodiments and arrangements, without thereby departing from the scope of the inventive idea underlying the invention itself. The possible presence of reference numbers in the attached claims has the purpose of facilitating reading thereof with reference to the description and to the table of drawings, and in no way limits the sphere of protection represented by the claims.

Claims

1. A machine for the production of corrugated cardboard, comprising:
 - a first corrugating roller (7);
 - a second corrugating roller (9) co-operating with the first corrugating roller for corrugating a sheet of web-like material (N), which passes between said first corrugating roller and said second corrugating roller, which are provided with projections that mesh together;
 - a gluing assembly (31) with a gluing cylinder (41), which co-operates with the first corrugating roller for applying a glue on the crests of said web-like material, the first corrugating roller and the gluing cylinder being turned at reciprocally different peripheral speeds;
 - a means for transmitting motion (73, 77) to said gluing cylinder;

- adjustment means for adjusting the position of the gluing cylinder with respect to the first corrugating roller;

characterized in that said adjustment means comprise a detector (109, 111, 115, 119) for detecting the angular displacement of said gluing cylinder (41) with respect to said motion transmission means (73; 77), the position of the gluing cylinder (41) with respect to the first corrugating roller (7) being regulated according to said angular displacement.

- Machine according to claim 1, **characterized in that** said gluing assembly (31) is movably mounted with respect to said first corrugating roller, the position of the gluing assembly being modified according to the angular position variation of the gluing cylinder (41) with respect to the motion transmission means.
- Machine according to claim 1 or 2, **characterized in that**: said motion transmission means includes a wheel (73) which is coaxial to said gluing cylinder (41), connected to it so that the gluing cylinder and the wheel can accomplish reciprocal angular movement, said wheel being moved by a transmission member (77); and **in that** a sensing means (119) is provided to detect the angular displacement between of the gluing cylinder (41) and the wheel (73).
- Machine according to claim 3, **characterized in that** limiting means are provided to limit the angular displacement between said wheel (73) and said gluing cylinder (41).
- Machine according to claim 4, **characterized in that** said limiting means comprise a pair of angular contrasts (107A, 107B).
- Machine according to claim 5, **characterized in that** said angular contrasts cooperate with a spline (103) movably mounted between the contrasts, said spline and said contrasts being respectively integral to said gluing cylinder and said wheel, or vice versa.
- Machine according to one or more of the preceding claims, **characterized in that** said detector comprises a mobile member (111, 115) cooperating with a cam (109), the relative position between said mobile member and said cam being determined by the angular position of said wheel and said gluing cylinder, a sensing means (119) being provided to detect the displacement of the mobile member driven by said cam.
- Machine according to claim 7, **characterized in**

that said mobile member is a pivoting member.

- Machine according to claim 7 or 8, **characterized in that** said mobile member is carried by said wheel and said cam is connected to said gluing cylinder.
- Machine according to claim 9, **characterized in that** said mobile member pivots on an axis oriented by approximately 90° with respect to the axis of the gluing cylinder and the wheel and **in that** said cam has the development of a circle arch around the axis of said gluing cylinder.
- Machine according to one or more of the claims from 7 to 10, **characterized in that** said sensing means comprises a microswitch which detects the position of the mobile member.
- Machine according to one or more of the claims 7 to 11, **characterized in that** said mobile member and said cam are housed in a compartment covered by a cover (113) which is integral with said wheel (73), in which there is an aperture (117) through which said sensing mean (119) determines the position of said mobile member.
- Machine according one or more of the preceding claims, **characterized in that** the gluing cylinder (41) is drawn in rotation with a peripheral speed lower than the peripheral speed of the sheet of web-like material run over said first corrugating roller.
- Machine according to claim 13, **characterized in that** the peripheral speed of the gluing cylinder is between 0.5% and 10% and preferably between 1% and 5% lower than the peripheral speed of said web-like material run over said first corrugating roller.
- Machine according to one or more of the preceding claims, **characterized in that** said gluing assembly is supported about an axis of oscillation (B) parallel to the axes of rotation of the first and second corrugating rollers and of the gluing cylinder, and in the working position rests against a contrast (42), the position of the axis of oscillation being modifiable for adjusting the position of the gluing cylinder with respect to the first corrugating roller.
- Machine according to claim 15, **characterized in that** said axis of oscillation is carried by an eccentric cam (33), associated to which is an actuator (35), the rotation of the eccentric cam by means of said actuator modifying the position of the axis of oscillation.
- Machine according to one or more of the preceding claims, **characterized in that** said second corru-

gating roller is carried by a pair of arms (13), to which is associated an actuator (17), which forces the second corrugating roller (9) against the first corrugating roller (7), and **in that** associated to said second corrugating roller (9) is a position sensor (19) for detecting the variation in position of the second corrugating roller, the signal generated by said sensor controlling the position of the gluing cylinder.

18. Machine according to claim 17, **characterized in that** said second corrugating roller has a diameter smaller than the diameter of the first corrugating roller.

19. Method for controlling the distance between a gluing cylinder and a first corrugating roller in a machine for the production of corrugated cardboard, comprising: said gluing cylinder (41), a motion transmission means (73, 77) of said gluing cylinder, said first corrugating roller (7), and a second corrugating roller (9) co-operating with said first corrugating roller for corrugating a sheet of web-like material (N) running over said first corrugating roller, on which said gluing cylinder applies an adhesive; wherein said gluing cylinder and said first corrugating roller are turned at reciprocally different peripheral speeds and are reciprocally approached until a frictional force is exchanged between the gluing cylinder and the sheet of web-like material, **characterized in that** the relative angular displacement between said gluing cylinder (41) and said motion transmission means (73, 77) is detected and the distance between said first corrugated roller and said gluing cylinder is adjusted according to said angular displacement.

20. Method according to claim 19, **characterized by** driving the gluing cylinder in rotation at a peripheral speed lower than the peripheral speed of the sheet of web-like material run over said first corrugating roller and by gradually approaching the gluing cylinder to the first corrugating roller until an angular displacement is detected of the gluing cylinder with respect to the motion transmission means.

21. Method according to claim 19 or 20, **characterized by** driving said gluing cylinder in rotation by means of a transmission wheel (73) coaxial therewith and detecting an angular displacement of the gluing cylinder which respect to said wheel (73).

22. Method according to one or more of the claims 19 to 21, **characterized in that**, when said angular displacement is detected, the approaching movement of said gluing cylinder and said first corrugating roller is stopped and said gluing cylinder and said corrugating roller are distanced by a predetermined extent to obtain a predetermined distance between

the surface of the gluing cylinder and said sheet of web-like material.

23. Method according to one or more of the preceding claims, **characterized in that**: during production of corrugated cardboard, the gluing cylinder is regularly approached to the first corrugating roller; **in that** each approach is stopped when said angular displacement is detected; and **in that** the gluing cylinder and the corrugating roller are each time distanced by a certain predetermined entity.

24. Method according to claim 22 or 23, **characterized in that** said predetermined entity varies according to the corrugated cardboard production speed.

25. Method according to one of more of the claims 19 to 24, **characterized by** the steps of:

- turning said first and second corrugating rollers, running said sheet of web-like material over said first corrugating roller;
- turning said gluing cylinder at a peripheral speed which is different than the peripheral speed of the web-like material run over the first corrugating roller;
- gradually approaching the gluing cylinder to the first corrugating roller until a working position is reached determined on the basis of the detection of a variation in the angular position of the gluing cylinder with respect to the motion transmission means associated therewith and adjusting the distance between said gluing cylinder and said corrugating roller according to the detection of said variation in angular position;
- detecting the variation in the position of the second corrugating roller with respect to the axis of rotation of the first corrugating roller; and
- modifying the position of the gluing cylinder with respect to the axis of rotation of the first corrugating roller as a function of the variation of the position of the second corrugating roller with respect to the axis of rotation of the first corrugating roller.

Fig.1

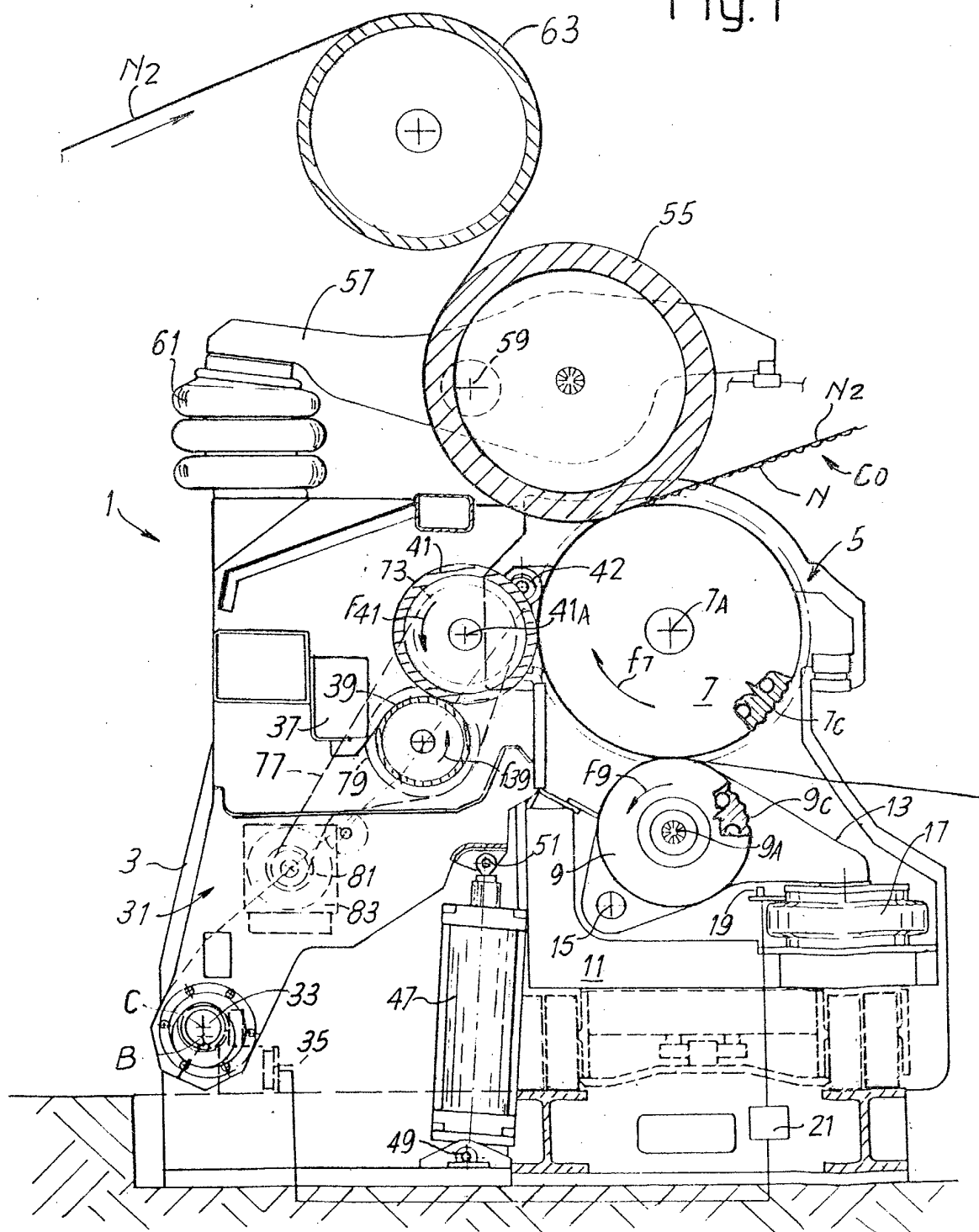
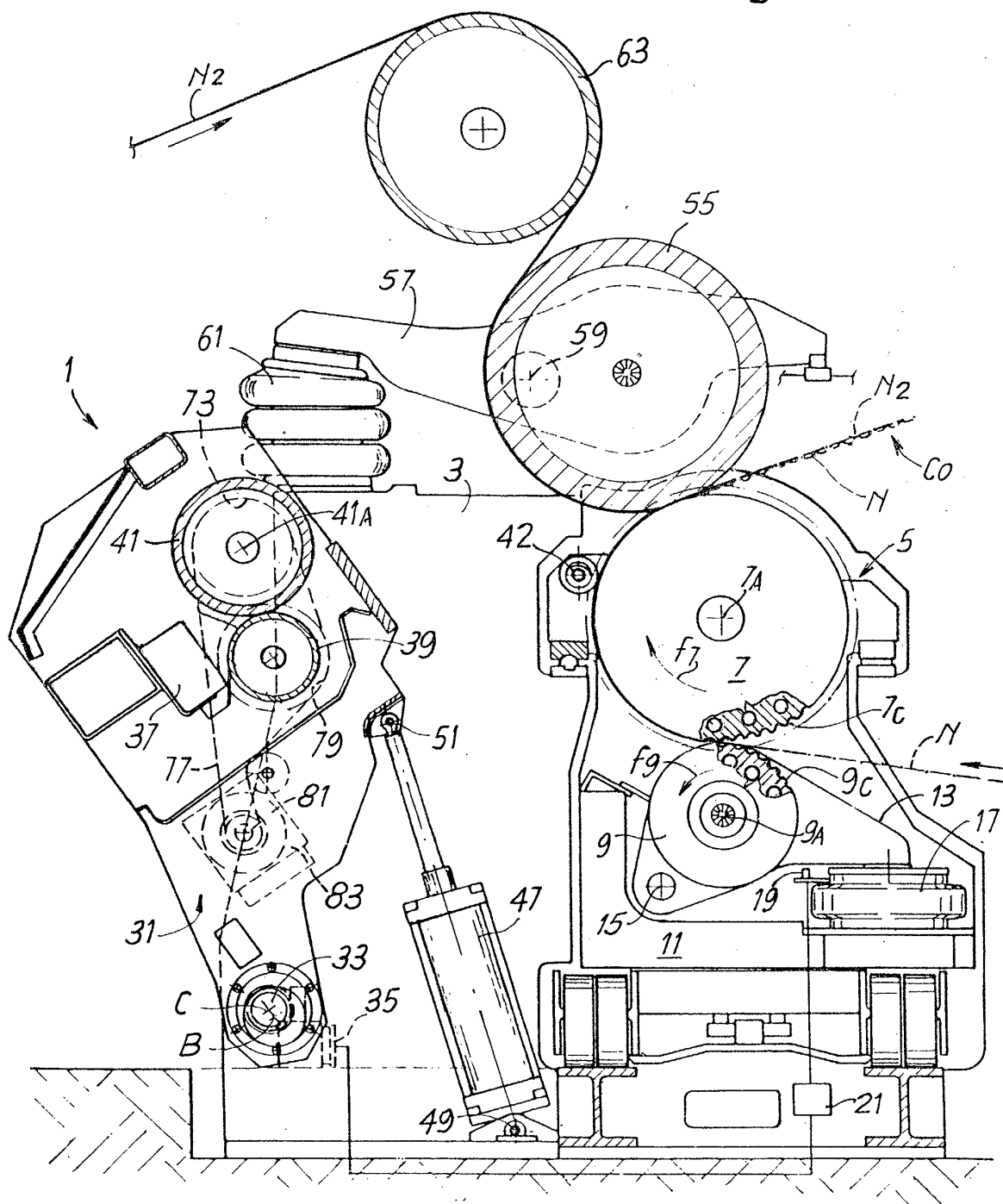
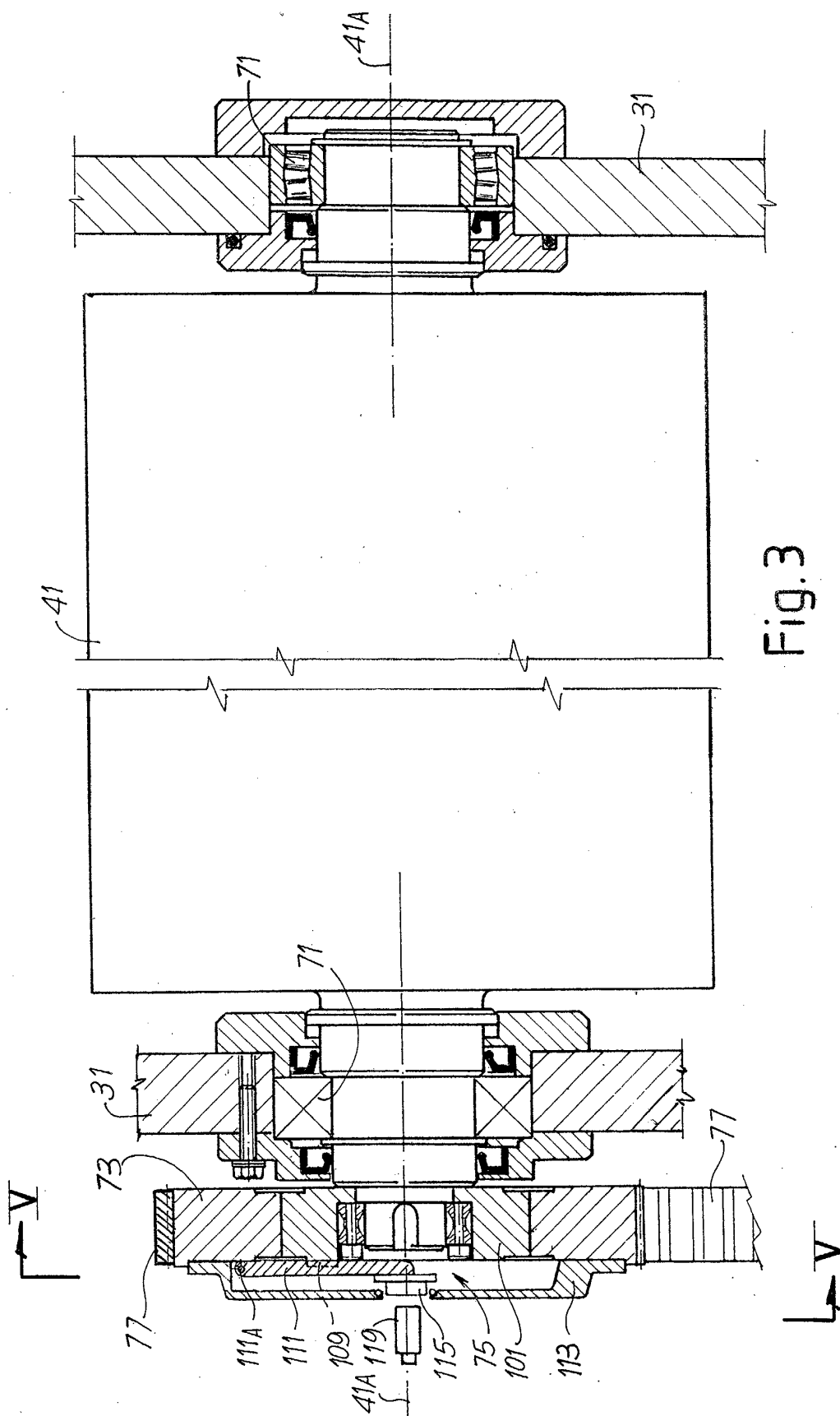


Fig.2





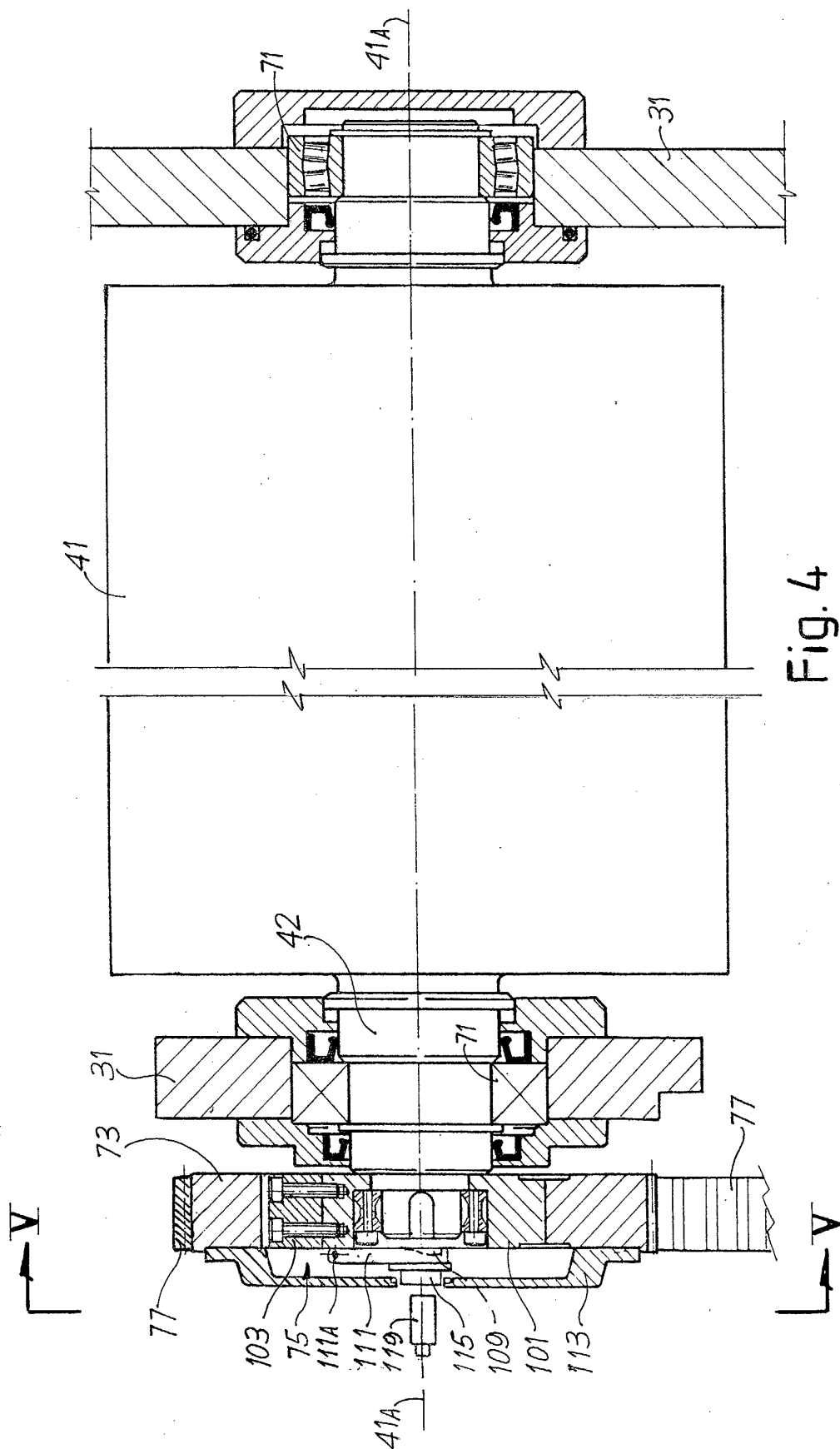


Fig. 4

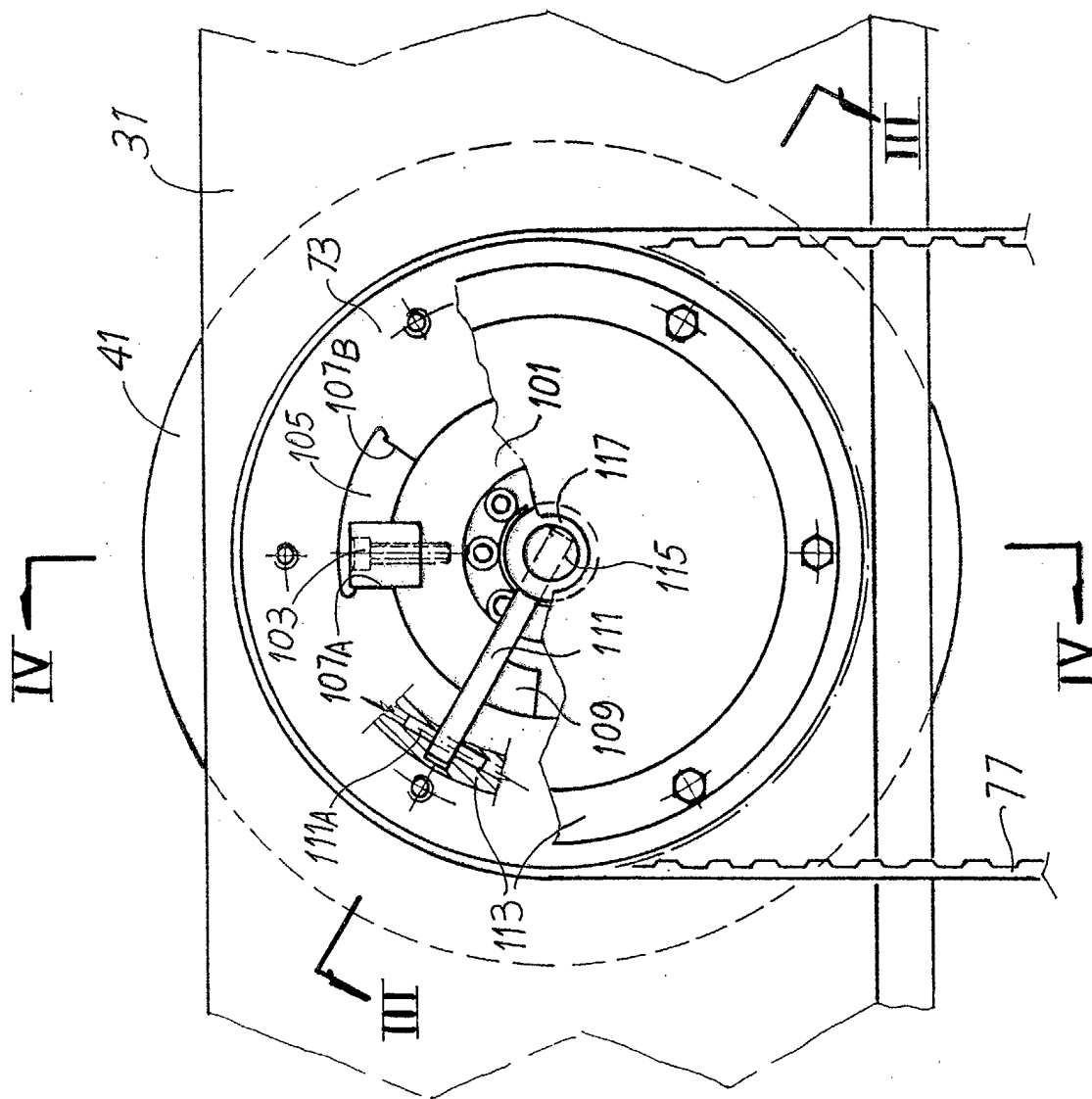


Fig. 5